## REMARKS

The Examiner's time and cooperation in his interview with Applicant's attorney is greatly appreciated. The claims have been amended as discussed at the interview and are allowable as indicated at the interview. This amendment constitutes a summary of the interview.

The present invention relates to both a method and apparatus for measuring distance utilizing the time of flight (TOF) principle. Under the TOF principle, the elapsed time between the transmission of electromagnetic radiation and the receipt of its echo is directly proportional to the distance measured since the speed of travel of the electromagnetic radiation is a known and fixed constant, i.e. the speed of light.

Utilization of the TOF principle to measure distances has been long known in the art. However, one difficulty with using the TOF principle to measure distances is that electromagnetic noise may interfere with the received echo of the transmitted electromagnetic radiation pulse. This is particularly true as the distance increases which likewise results in a reduced strength of the echo pulse with an increase in distance measured.

There have, however, been previously known methods and apparatuses which utilize the TOF principle to measure distance and which also use various systems to reduce the effect of electromagnetic noise during the receipt of the echo. For example, U.S. Patent Application Publication No. 2003/0035097 to Lai discloses a method and apparatus for measuring distances using the TOF principle including means to compensate for electromagnetic noise. In the Lai application, Lai employs a receiver threshold 80 to an analog receiving signal 70 of the receiver. In the time intervals $T_n$ in which the signal 70 lies above the threshold 80, these time intervals are associated with the value "1" while a value of "0" is associated with the time intervals $T_n$ in which the signal 70 is below the threshold 80. Accordingly, the shortest pulse lying above the

threshold 80 corresponds to one time interval $T_n$, i.e. one point in time according to Lai is the time between the signal 70 passing the threshold 80 from below and a subsequent passing of the threshold 80 from above. This is clearly illustrated in FIG. 3 of the Lai application.

In order to clearly identify the signal pulse at time $T_d$ and to differentiate the real signal pulse from the noise, Lai simply accumulates a plurality of individual TOF measurements that are sequentially obtained. These measurements of the real signal pulse at time $T_d$, together with the noise, are simply added together over a plurality of different measurements, for example eight different TOF measurements.

Due to the statistical nature of noise, i.e. that the noise is generally random, the noise distribution over the time domain is random for each of the several TOF measurements while the true return signal pulse at time $T_d$ is not but rather occurs at the same elapsed time for each of the numerous sequential measurements. Consequently, in order for the Lai application to identify the real echo radiation and to differentiate that radiation from the random noise, Lai effectively creates a digital curve of the received signal above a threshold 80 for the first TOF measurement. Similarly a second digital curve is created for the received echo and noise above the threshold 80 for the second pulse and these two digital wavelengths are added together. The same is true for the third and sequential received echoes and radiation until the final TOF measurement at which time the echo pulse at time $T_d$ is clearly identified.

While the Lai device accurately identifies the reflected echo signals of the electromagnetic radiation, a large amount of brute computing power is required in order to not only create the digital curves, best shown in FIG. 3 of Lai, for each TOF measurement, but also significant computing power is needed to add the sequential TOF digital curves together as required by Lai.

U.S. Patent Application Publication No. 2004/0075823 to Lewis also discloses a distance measuring apparatus which utilizes the TOF principle for electromagnetic radiation. The Lewis application also addresses and compensates for noise received by the receiver and to extract the true echo signal from the ever-present noise surrounding that true signal.

Lewis, however, operates differently from the Lai patent. Specifically, Lai utilizes a so-called histogram processor which collects waveform samples, i.e. digital curves, at varying comparison thresholds; see paragraph [0015] in Lewis. By varying these thresholds and analyzing the plurality of waveforms obtained at these different thresholds increases the overall accuracy of the TOF distance measurement.

However, like the Lai application, Lewis also creates a digital curve of the received echo signal together with accompanying noise at each of the different comparison thresholds. Lewis then, like Lai, requires substantial computing power to add the different digital curves or histograms together for each sequential TOF electromagnetic pulse in order to obtain the final digital curve having the true signal clearly differentiated from the random background noise.

The actual operation of the histogram processor of Lewis is perhaps best explained in paragraph [0087] of the Lewis application. In short, Lewis utilizes a control engine 20 which aggregates the histogram information at each threshold to create a composite waveform that serves as a digital replication of the waveform received by the laser diode 26.

Consequently, both the Lewis and Lai patents are similar to each other in that both compute complete digital curves of the received signal intermixed with noise. This, in turn, requires relatively high computing power and time, as well as computer memory.

The Patent Examiner has rejected the claims in this case as unpatentable over either Lewis or Lai alone, or when combined together. However, in view of the amendment made to

the patent claims, Applicant respectfully submits that this basis for rejection should be withdrawn.

More specifically, in sharp contrast to the Lewis and Lai patents, the present invention operates on the basis of a greatly reduced set of information by using only those points 33 in time at which the received analog signal of the receiver passes through an established threshold.

This is particularly evident in FIGS. 2A-2C of the patent drawing. In FIG. 2A, the number 37 represents the analog signal from the receiver while the number 21 represents the receiver threshold. In FIG. 2B, a digital graph comprising local pulses 23 of the analog received signal 37 of FIG. 2A is shown. Thus, FIG. 2B is a digital representation of the received signal intermixed with noise but in which the level of the signal only changes between two preset values, 0 and 1, at the point 33 where the received signal passes through a preset threshold.

In order to identify the true signal and extract it from the noise, the present invention averages a plurality of sequential TOF measurements. However, unlike the prior art cited by the Patent Examiner, this averaging only includes the specific points in time 33 when the received signal passes through the threshold, rather than a digital curve representing the entire received signal and noise as in the Lewis and Lai applications.

In other words, the present invention differs from Lewis and Lai in that the present invention performs an averaging process on the basis of individual measurements at only the specific points in time 33 where the received signal passes either up or down through a threshold thereby avoiding the handling, storage and computational power required to create and manipulate entire digital curves as is required in both the Lai and the Lewis patent applications. This, in turn, enables a less expensive, less complex and yet highly effective means to extract an electromagnetic radiation echo from background noise.

Furthermore, this aspect of Applicant's invention is clearly defined in the claims submitted concurrently herewith. Specifically, claim 33 is directed to a method and clearly defines that the noise is measured using the receiver 17 only at specific points in time 33. Claim 33 also clearly defines that those specific points correspond to the point in time in which the signal from the receiver passes through the threshold 21. Claim 33 also clearly defines the step of averaging a plurality of individual measurements which include the specific points in time 33.

Since claim 33 clarifies that the noise is measured only at specific points in time which correspond to those points in time in which the signal passes through the threshold, either going up or going down, claim 33 clearly defines Applicant's invention over both the Lewis and Lai patents, both of which not only maintain and manipulate, but also store complex digital curves representative of the entire analog received signal. Furthermore, as discussed above, the present invention greatly reduces the complexity and cost of the TOF measuring method and device as compared to the Lai and Lewis patent without any loss of accuracy. Therefore, it would not be obvious to modify either the Lai or Lewis device in order to obtain Applicant's invention. Otherwise, both Lai and Lewis would disclose Applicant's method in view of the substantial and significant advantages of Applicant's method and apparatus over both the Lai and the Lewis patents.

Claim 55 forms the second independent claim in the instant application. Claim 55 is an apparatus claim which corresponds in scope to the method claim 33 discussed above. Therefore, the same arguments set forth above with respect to claim 33 are equally applicable to claim 55 and are incorporated by reference.

New claim 63 is presented for review and allowance by the Patent Examiner at this time. New claim 63 is a method claim which corresponds to claim 33 but includes the further

limitations that the sequence of pulses 23 is generated by the threshold 21 of the receiver and that the flanks of the logical pulses 23 are used as the points in time 33 for the individual measurements. There is no corresponding structure or method, at all, in the Lewis or Lai patents cited by the Patent Examiner.

New claim 64 forms the fourth and last independent claim in the instant application. New claim 64 corresponds to claim 33 but with the additional limitation that the averaging between the points in time 33 at which the signal passes upwardly through the threshold is the same as those points in time 33 that the signal passes downwardly through the threshold. There is no corresponding structure or method in either the Lewis or Lai patents.

In view of the foregoing, Applicant respectfully submits that the instant application is in condition for formal allowance and such action is respectfully solicited.

The Director is hereby authorized to charge any deficiency in the fees filed, asserted to be filed or which should have been filed herewith (or with any paper hereafter filed in this application by this firm) to our Deposit Account No. 07-1180.

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